Cummins Advanced Reciprocating Engine Technology for California Distributed Generation

Vinod K Duggal

Cummins Inc.

CEC - ARICE Workshop

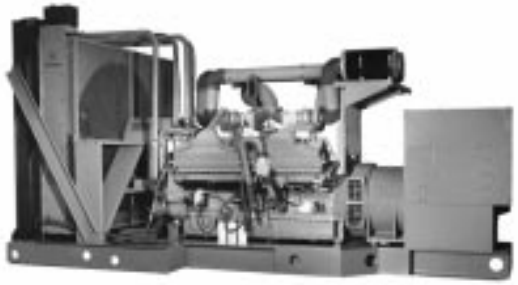
Sacramento - July 10, 2001

Outline

- Cummins Overview
- Power Gen Solutions Today
- Why Lean-Burn Natural Gas Recip?
- Ongoing Technologies & Innovations
- Summary

Cummins Overview

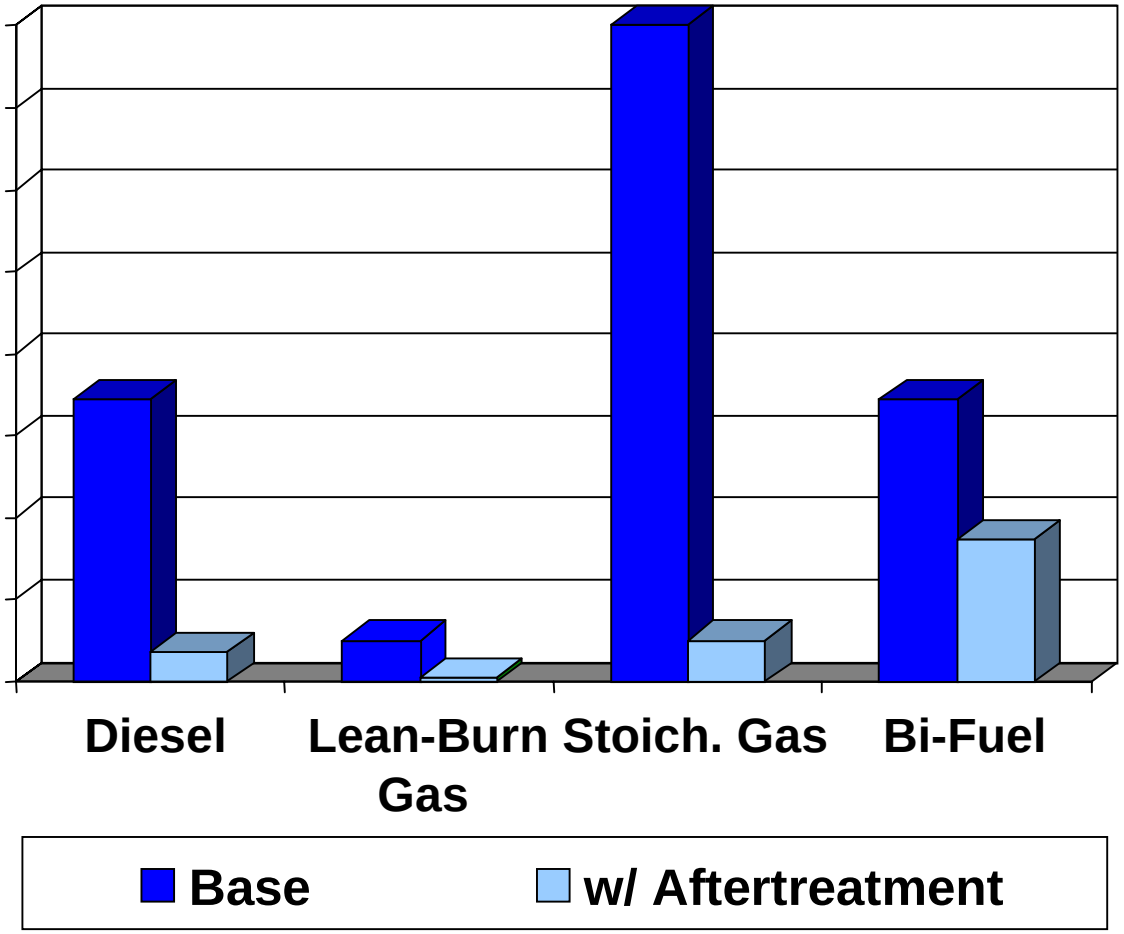
- Cummins Power Generation
  - Cummins, Inc: $6.6B Sales, 28,500 employees
  - Cummins Power Generation: $1.4B Sales, over 500,000 units in service
  - The “Power of One”: Integrated Design, Sourcing, and Support of engine, alternator, controls, switchgear
- Cummins presence in today’s California market
  - Year-to-date over 240 MW sold and over 70 MW rented to West Coast

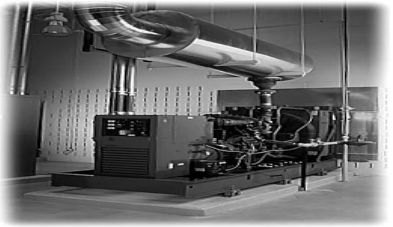


Cummins Solutions Today

Power Generation

NOx Emissions Levels

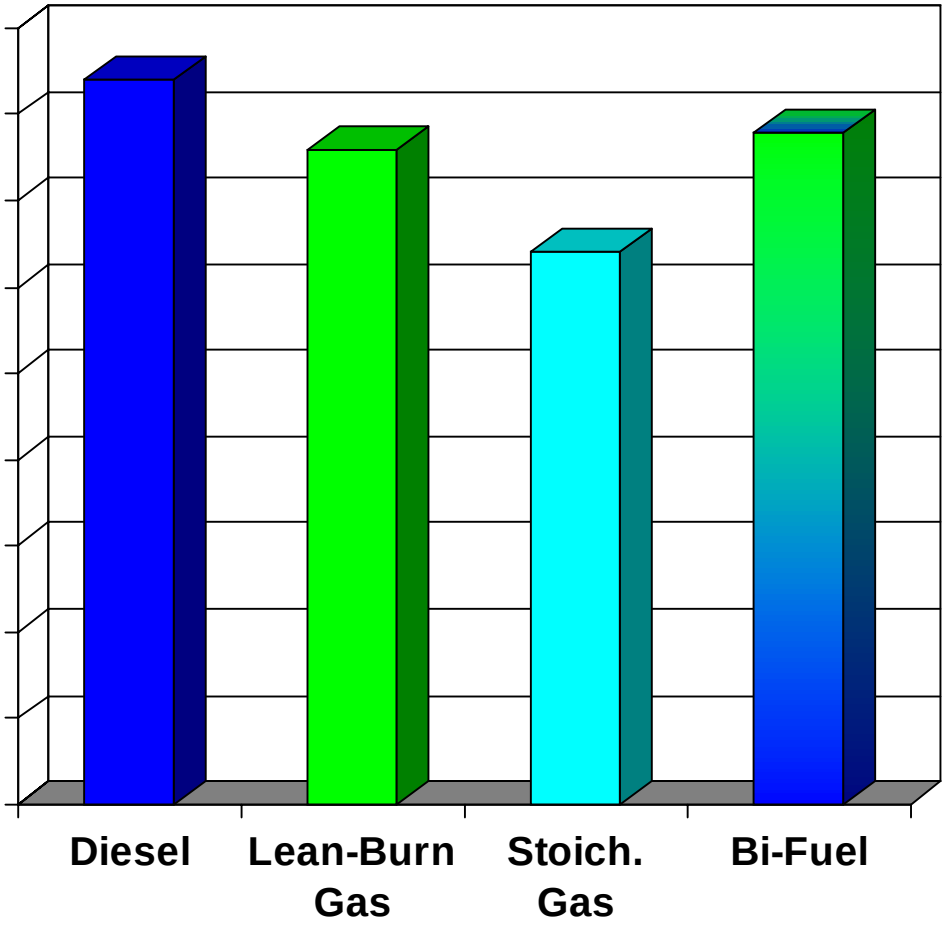




Why Lean-burn Natural Gas Recip?

Power Generation

Efficiency Levels



Ongoing Innovations

- Advanced Lean-Burn Natural Gas (ARES)
  - Cost effective reduced emissions: After-treatment
  - Improved efficiency: Parasitic reduction & combustion system
  - Extended maintenance intervals: Ignition System Solutions
  - Reduced initial cost: Higher BMEP

- Cummins-Westport Inc.
  - HPDI

- Micro-turbines
  - Niche markets

Westport Demo Genset

- Based on QSK60
- Functional 2Q2001
- 1.6 MWe Continuous
- Onboard switchgear and grid paralleling controls.

- Parallel Grid Connect or operation with load banks

- Customer field demonstrations planned for 4Q2001

Anaheim Emissions Profile

- Ultra-low emissions:
  - NO_x < 0.26 g/bhp-hr (25 ppm)
  - CO < 0.15g/bhp-hr
  - VOC < 0.15 g/bhp-hr
  - PM < 0.045 g/bhp-hr

- Requires:
  - SCR - Selective Catalytic Reduction for NO_x
  - DPF - Diesel Particulate Filter for PM
  - Oxy Cat - Oxidation Catalyst for CO & HC

Summary

- Range of solutions to meet California's power generation needs
- Cummins dedicated to meeting future emissions and efficiency requirements
- The improvements needed will take time and resources Consortium efforts are essential to accelerate these developments
- Lean-burn natural gas offers the best trade-offs